

(b) Keep paper records of your in-use testing for one full year after you complete all the testing required for an engine family in a model year. You may use any additional storage formats or media if you like.

(c) Keep a copy of the written reports described in § 1048.420.

(d) Keep any additional records related to the procurement process.

[67 FR 68347, Nov. 8, 2002, as amended at 70 FR 40476, July 13, 2005]

### Subpart F—Test Procedures

#### § 1048.501 How do I run a valid emission test?

(a) Use the equipment and procedures for spark-ignition engines in 40 CFR part 1065 to determine whether engines meet the duty-cycle emission standards in § 1048.101(a) and (b). Measure the emissions of all the pollutants we regulate in § 1048.101 using the sampling procedures specified in 40 CFR part 1065. Measure CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub> as described in § 1048.235. Use the applicable duty cycles specified in §§ 1048.505 and 1048.510.

(b) Section 1048.515 describes the supplemental procedures for evaluating whether engines meet the field-testing emission standards in § 1048.101(c).

(c) Use the fuels and lubricants specified in 40 CFR part 1065, subpart H, to perform valid tests for all the testing we require in this part, except as noted in § 1048.515. For service accumulation, use the test fuel or any commercially available fuel that is representative of the fuel that in-use engines will use.

(d) In place of the provisions of 40 CFR 1065.405, you may consider emission levels stable without measurement after 50 hours of engine operation.

(e) To test engines for evaporative emissions, use the equipment and procedures specified for testing diurnal emissions as described in 40 CFR 1060.525, subject to the following provisions:

(1) Precondition nonmetal fuel tanks as specified in 40 CFR 1060.520(a) and (b).

(2) For engines equipped with carbon canisters that store fuel vapors that will be purged for combustion in the engine, precondition the canister as

specified in 40 CFR 86.132–96(h) and then operate the engine for 60 minutes over repeat runs of the duty cycle specified in Appendix I of this part.

(3) Start the diurnal emission test after the engine is stabilized at room temperatures, but within 36 hours after the engine operation specified in paragraph (e)(2) of this section.

(4) You may not separately measure permeation emissions from nonmetal fuel tanks for subtracting from the diurnal emission measurement.

(5) Note that you may omit testing for evaporative emissions during certification if you certify by design, as specified in § 1048.245.

(f) You may use special or alternate procedures to the extent we allow them under 40 CFR 1065.10.

(g) This subpart is addressed to you as a manufacturer, but it applies equally to anyone who does testing for you, and to us when we perform testing to determine if your engines meet emission standards.

[70 FR 40476, July 13, 2005, as amended at 73 FR 59239, Oct. 8, 2008; 74 FR 56510, Oct. 30, 2009]

#### § 1048.505 How do I test engines using steady-state duty cycles, including ramped-modal testing?

This section describes how to test engines under steady-state conditions. In some cases, we allow you to choose the appropriate steady-state duty cycle for an engine; you may also choose between discrete-mode and ramped-modal testing. In all cases, you must use the duty cycle you select in your application for certification for all testing you perform for that engine family. If we test your engines to confirm that they meet emission standards, we will use the duty cycles you select for your own testing. If you submit certification test data using more than one duty cycle, any of the selected duty cycles may be used for any subsequent testing. We may also perform other testing as allowed by the Clean Air Act.

(a) You may perform steady-state testing with either discrete-mode or ramped-modal cycles described in 40 CFR Part 1065.

(b) Measure emissions by testing the engine on a dynamometer with one or

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more of the following sets of duty cycles to determine whether it meets the steady-state emission standards in § 1048.101(b):

(1) For engines from an engine family that will be used only in variable-speed

applications, use one of the following duty cycles:

(i) The following duty cycle applies for discrete-mode testing:

**TABLE 1 OF § 1048.505**

C2 mode No.	Engine speed <sup>1</sup>	Torque (percent) <sup>2</sup>	Weighting factors
1 .....	Maximum test speed .....	25	0.06
2 .....	Intermediate test .....	100	0.02
3 .....	Intermediate test .....	75	0.05
4 .....	Intermediate test .....	50	0.32
5 .....	Intermediate test .....	25	0.30
6 .....	Intermediate test .....	10	0.10
7 .....	Warm idle .....	0	0.15

<sup>1</sup> Speed terms are defined in 40 CFR part 1065.

<sup>2</sup> The percent torque is relative to the maximum torque at the given engine speed.

(ii) The following duty cycle applies for ramped-modal testing:

**TABLE 2 OF § 1048.505**

RMC mode	Time in mode (seconds)	Engine speed <sup>1 2</sup>	Torque (percent) <sup>2 3</sup>
1a Steady-state .....	119	Warm idle .....	0
1b Transition .....	20	Linear transition .....	Linear transition.
2a Steady-state .....	29	Intermediate speed .....	100
2b Transition .....	20	Intermediate speed .....	Linear transition.
3a Steady-state .....	150	Intermediate speed .....	10
3b Transition .....	20	Intermediate speed .....	Linear transition.
4a Steady-state .....	80	Intermediate speed .....	75
4b Transition .....	20	Intermediate speed .....	Linear transition.
5a Steady-state .....	513	Intermediate speed .....	25
5b Transition .....	20	Intermediate speed .....	Linear transition.
6a Steady-state .....	549	Intermediate speed .....	50
6b Transition .....	20	Linear transition .....	Linear transition.
7a Steady-state .....	96	Maximum test speed .....	25
7b Transition .....	20	Linear transition .....	Linear transition.
8 Steady-state .....	124	Warm idle .....	0

<sup>1</sup> Speed terms are defined in 40 CFR part 1065.

<sup>2</sup> Advance from one mode to the next within a 20-second transition phase. During the transition phase, command a linear progression from the torque setting of the current mode to the torque setting of the next mode.

<sup>3</sup> The percent torque is relative to maximum torque at the commanded engine speed.

(2) For engines from an engine family that will be used only at a single, rated speed, use the 5-mode duty cycle or the corresponding ramped-modal cycle described in 40 CFR part 1039, Appendix II, paragraph (a).

(3) Use a duty cycle from both paragraphs (b)(1) and (b)(2) of this section if you will not restrict an engine family

to constant-speed or variable-speed applications.

(4) Use a duty cycle specified in paragraph (b)(2) of this section for all severe-duty engines.

(5) For high-load engines, use one of the following duty cycles:

(i) The following duty cycle applies for discrete-mode testing:

**TABLE 3 OF § 1048.505**

Mode No.	Engine speed	Torque (percent) <sup>1</sup>	Minimum time in mode (minutes)	Weighting factors
1 .....	Maximum test speed .....	100	3.0	0.50

TABLE 3 OF § 1048.505—Continued

Mode No.	Engine speed	Torque (percent) <sup>1</sup>	Minimum time in mode (minutes)	Weighting factors
2 .....	Maximum test speed .....	75	3.0	0.50

<sup>1</sup> The percent torque is relative to the maximum torque at maximum test speed.

(ii) The following duty cycle applies for discrete-mode testing:

TABLE 4 OF § 1048.505

RMC modes	Time in mode (seconds)	Engine speed (percent)	Torque (percent) <sup>1 2</sup>
1a Steady-state .....	290	Engine governed .....	100
1b Transition .....	20	Engine governed .....	Linear transition.
2 Steady-state .....	290	Engine governed .....	75

<sup>1</sup> The percent torque is relative to maximum test torque.

<sup>2</sup> Advance from one mode to the next within a 20-second transition phase. During the transition phase, command a linear progression from the torque setting of the current mode to the torque setting of the next mode.

(c) For full-load operating modes, operate the engine at wide-open throttle.

[73 FR 59239, Oct. 8, 2008, as amended at 75 FR 23022, Apr. 30, 2010; 79 FR 23751, Apr. 28, 2014]

#### § 1048.510 What transient duty cycles apply for laboratory testing?

(a) Starting with the 2007 model year, measure emissions by testing the engine on a dynamometer with the duty cycle described in Appendix II to determine whether it meets the transient emission standards in § 1048.101(a).

(b) Calculate cycle statistics and compare with the established criteria as specified in 40 CFR 1065.514 to confirm that the test is valid.

(c) Warm up the test engine as follows before running a transient test:

(1) Operate the engine for the first 180 seconds of the appropriate duty cycle, then allow it to idle without load for 30 seconds. At the end of the 30-second idling period, start measuring emissions as the engine operates over the prescribed duty cycle. For severe-duty engines, this engine warm-up procedure may include up to 15 minutes of operation over the appropriate duty cycle.

(2) If the engine was already operating before a test, use good engineering judgment to let the engine cool down enough so measured emissions during the next test will accurately represent those from an engine starting at room temperature. For example, if an engine starting at room tempera-

ture warms up enough in three minutes to start closed-loop operation and achieve full catalyst activity, then minimal engine cooling is necessary before starting the next test.

(3) You are not required to measure emissions while the engine is warming up. However, you must design your emission-control system to start working as soon as possible after engine starting. In your application for certification, describe how your engine meets this objective (see § 1048.205(b)).

[67 FR 68347, Nov. 8, 2002, as amended at 70 FR 40478, July 13, 2005; 73 FR 59241, Oct. 8, 2008; 75 FR 23023, Apr. 30, 2010]

#### § 1048.515 What are the field-testing procedures?

(a) This section describes the procedures to determine whether your engines meet the field-testing emission standards in § 1048.101(c). These procedures may include any normal engine operation and ambient conditions that the engines may experience in use. Paragraph (b) of this section defines the limits of what we will consider normal engine operation and ambient conditions. Use the test procedures we specify in § 1048.501, except for the provisions we specify in this section. Measure emissions with one of the following procedures:

(1) Remove the selected engines for testing in a laboratory. You may use an engine dynamometer to simulate